HEADQUARTERS
QUARTERMASTER RESEARCH & ENGINEERING COMMAND
U S ARMY

TECHNICAL REPORT
EP-88

A METHOD FOR ASSESSING AND MAPPING THE JANUARY DAILY MINIMUM TEMPERATURES OF NORTHERN NORTH AMERICA

QUARTERMASTER RESEARCH & ENGINEERING CENTER
ENVIRONMENTAL PROTECTION RESEARCH DIVISION

MAY 1958

NATICK, MASSACHUSETTS

BEST

AVAILABLE

COPY

HEADQUARTERS
QUARTERMASTER RESEARCH & ENGINEERING COMMAND, US ARMY
OFFICE OF THE COMMANDING GENERAL
NATICK, MASSACHUSETTS

FC
BAC

Major General Andrew T. McNamara
The Quartermaster General
Washington 25, D. C.

Dear General McNamara:

This report, "A Method for Assessing and Mapping the January Daily Minimum Temperatures of Northern North America," presents a simple graphic method for assessing probable daily minimum temperatures for January in that part of North America north of latitude 55°N. This method is especially noteworthy because the only data required for its operation are mean daily minimum temperature, the lowest minimum of record, and the length of record. Such information, usually available from even the most abbreviated weather records, is all that is needed for the making of relatively precise estimates of daily minimum temperature frequencies.

By applying the method to data from 71 weather stations, well scattered over northern Canada, Alaska, Greenland, and Iceland, a comprehensive table of daily minimum temperature probabilities has been constructed. Several illustrative maps have been drawn showing the percentage of days the minimum temperature may be expected to reach or exceed a given level, or the estimated daily minimum temperature which may be expected on a specified percentage of days.

Information on daily minimum temperatures can be useful for many military purposes. If maps needed to fill a specific requirement are not included in this report, the tables of expected frequencies can quickly supply the data necessary for stating daily minimum temperatures in terms bearing on the specific problem.

Sincerely yours,

C. G. Calloway
C. G. CALLOWAY
Major General, USA
Commanding

1 Incl
EP-88

HEADQUARTERS QUARTERMASTER RESEARCH & ENGINEERING COMMAND, US ARMY
Quartermaster Research & Engineering Center
Natick, Massachusetts

ENVIRONMENTAL PROTECTION RESEARCH DIVISION

Technical Report
EP-88

A METHOD FOR ASSESSING AND MAPPING THE JANUARY DAILY MINIMUM TEMPERATURES OF NORTHERN NORTH AMERICA

Earl E. Lackey, Ph.D.
Geographer

Environmental Analysis Branch

Project Reference:
7-83-01-005A

May 1958

Foreword

The number of days in January or the percentage of days that the temperature may fall to any given minimum or lower is information critical in military operations in northern North America. As a rule, only the extreme daily minimum and the mean daily minimum are available in published records. For military purposes it is desirable that responsible personnel be able to assess minimum temperature probabilities.

This report describes a simple, graphic method of ascertaining and mapping the probabilities - in days per month or in percentage of days - for any given minimum temperature in northern North America.

AUSTIN HENSCHEL, Ph.D.
Chief
Environmental Protection Research Division

Approved:

WILBUR M. SKIDMORE, Colonel, QMC
Commanding Officer
QM R and E Center Laboratories

A. STUART HUNTER, Ph.D.
Scientific Director
QM Research and Engineering Command

Contents

Abstract

~~This report presents~~ a method of assessing and mapping the January daily minimum temperature for northern North America (Canada north of 55°N lat., Alaska, Greenland, and Iceland) is described.

The method of assessing the frequency of daily minima requires only: (a) the mean daily minimum, (b) the absolute minimum, and (c) the length of the record. By use of these data and an adjusted probability scale, the frequency or percentage distribution of daily minimum temperatures for a station may quickly be ascertained.

The adjusted probability scale was used in estimating the daily minimum probabilities for 71 stations in northern North America. Five maps constructed from the tabulated data show how the table may be used to give an overview of the whole Arctic area, featuring any selected temperature frequency. ~~The Appendix explains how the mean monthly temperature may be used to achieve the same results. However, the results are not quite as accurate.~~

A Method for Assessing and Mapping the January Daily Minimum Temperatures of Northern North America

1. Introduction

Nearly everyone associated with Quartermaster Corps activities is interested one way or another in daily extremes of temperature. For example, suppose one wants to know how many days in January the temperature at Fort Churchill, Canada, might be expected to fall to -45°F or lower. Factors which must be taken into account in assessing the frequency of low daily minima are numerous, and, for the most part, are not independent but are intricately interrelated. Among these factors are: (1) development and movement of air masses, (2) differences in latitude as related to length of day and night, (3) seasonal variation in the angle of the sun's rays, (4) continental and marine effects, (5) radiation balance of the local terrain, (6) tendency toward the repetition of extremes, (7) tendency toward isolation of extremes, (8) tendency toward skewness, (9) length of available records, and (10) many other more or less intangible factors. Even though the temperature record is a compound of many variables, can a graphic scale be devised on which the January daily minimum temperature probabilities will fall approximately on a straight line? If so, then any two critical temperatures in the record would serve to determine the straight line.

2. Construction of a Probability Scale Showing Daily Minimum Temperatures on a Straight Line.

If the actual temperatures at Churchill, Canada (Table I) are plotted on a normal probability scale (Fig. 1), they will fall on a broken line (0°F to -49°F). If these values were normally distributed, all would fall on a straight line, and any two (e.g., mean daily minimum and lowest minimum) would determine this straight line.

a. Constructing a Straight Line Scale for a Single Station

However, a scale can be so constructed that all of these January temperatures for Churchill will fall on a straight line. This is done by plotting the mean daily minimum (-24.5°F) on the 50 percentile, the lowest minimum (-49°F) in the 310 days on the 0.32 percentile (normal scale), and drawing a straight line through the two points. The latter value (0.32) represents the lowest minimum for one day - the percentage that one day is of the whole number of days (310 minima) in the record (reciprocal of 310 = 1/310 = 0.32). The temperature values previously plotted on the normal scale can now be moved horizontally to the straight line (see arrows, Fig. 1). It should be noted that the broken line and the straight line have only two ordinates in common, namely, the ones for the mean-daily minimum and the lowest minimum. All the other temperatures with their percentage values have been moved from their broken line positions to their corresponding straight line positions. Thus, the broken line pattern of January

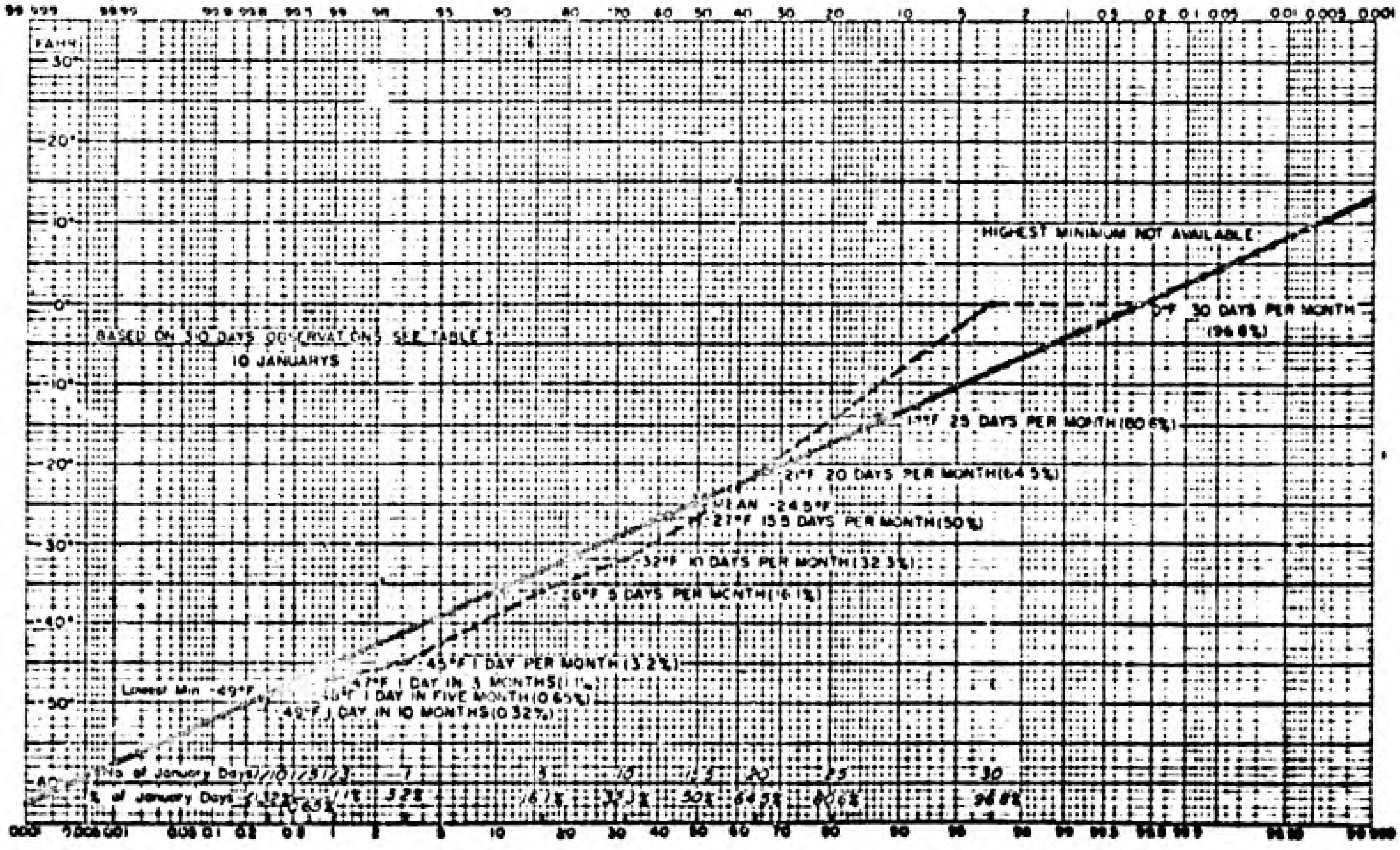

Figure 1. Churchill, Canada - January Daily Minimum Temperature

daily minimum temperature frequencies, as shown on the normal probability scale, has been transformed into a straight line pattern on the adjusted scale.

This report next provides the answer to the question: Can the above technique be used in constructing an adjusted straight line probability scale for an area as well as for a single station?

b. Construction of a Daily Minimum Temperature Probability Scale for Northern North America

The locations of seven Canadian and three Alaskan weather stations are shown by rectangles (▭) on Figure 2 and for each of these a record of January daily minimum temperatures was available. These ten "component" stations represent a land area from Churchill (58° N.) to Pond Inlet (72°N.), and from the Atlantic Ocean on the east to the Bering Sea on the west. The mean daily minimum*, absolute (lowest) minimum, and length of record (number of days) for each of these ten stations are shown in Table I.

The frequency distribution of daily minima at 1-degree (F) intervals was available for 10 years or more at these ten stations. These daily minima were rearranged into number and percentage frequencies per month (30, 25, 20, 15.5, 10, 5, 1, 1/3, 1/5, and 1/10 days (i.e., once in ten years)) as shown in Table I**, and then the temperatures in each of the frequency columns were averaged as indicated in the last line in the table.

On a normal probability scale (see Figure 3), a straight line was drawn from the average of the mean daily minima (-23°F, the average of Column 2, Table I) to the average of the absolute (lowest) minima (-57.3°F), average of Column 3, Table I)***, and this line was prolonged to the right margin of the scale (Figure 3)****. Next, each of the 10 frequency temperatures (25 days, 20 days, etc., Table I), was plotted at the appropriate point on the normal scale. When moved horizontally to the straight line, these points determine the positions of the vertical probability lines (ordinates). When the construction lines and data are removed from

---

*An adjusted scale using the mean monthly temperature would be nearly as good as one based on the mean daily minimum (see Appendix).

**If it were desired, the table could show any other daily time interval than the ones given.

***Average length of record (average of Column 4) is 370 days. Reciprocal 370 = 0.0027 or 0.27%. This is the location of -57.3°F at the bottom of the normal probability scale.

****This line is prolonged to the right margin because the high minima usually are not listed in abridged tables. Of course, this reduces the reliability of the upper half of the adjusted scale. Also, more than 16% (96.8 - 80.6%) of the frequencies occur between the 30-days and 25-days interval.

Table I: Frequencies of January Daily Minimum Temperatures (°F) for Ten Component Stations, Northern North America

COMPONENT STATIONS	Essential Data Mean Daily Min.	Absolute Min.	No. of Days in Record	Actual Frequencies in Percentages and days per month with given minimum or lower* 30 (96.8)	25 (80.6)	20 (64.5)	15.5 (50.0)	10 (32.3)	5 (16.1)	1 (3.2)	1/3 (1.1)	1/5 (0.65)	1/10 (0.32)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
CANADA													
Aklavik	-27.8	-58	341	-2	-16	-23	-29	-37	-45	-52	-54	-56	-58
Churchill	-24.5	-49	310	0	-14	-21	-27	-32	-36	-45	-47	-48	-49
Coppermine	-25.6	-54	279	-2	-15	-22	-28	-33	-38	-45	-50	-52	-54
Dawson	-25.0	-66	434	+5	-7	-16	-24	-35	-46	-57	-60	-64	-66
Ft. Smith	-23.8	-64	401	+6	-10	-18	-24	-34	-43	-56	-60	-61	-64
Pangnirtung	-21.1	-46	330	+12	-10	-20	-23	-30	-36	-42	-44	-45	-46
Pond Inlet	-32.1	-56	339	-7	-21	-28	-33	-41	-46	-53	-55	-56	-57
ALASKA													
Barrow	-18.3	-56	432	+7	-6	-12	-20	-26	-32	-40	-44	-46	-55
Kotzebue	-13.6	-56	406	+19	+3	-6	-16	-24	-32	-42	-53	-55	-56
Tanana	-17.8	-68	424	+12	-1	-8	-15	-26	-38	-56	-61	-64	-65
AVERAGES	-23.0	-57.3	370	+5	-9.7	-17.4	-23.9	-31.8	-39.2	-48.9	-52.8	-54.6	-57.0

*Any other frequency intervals could have been chosen. The percentages would be different for shorter months. Figures in parentheses represent percent number of days is of total.

Comment on January daily minima at Churchill: (in °F)
Between -31°, and -36°, 5 days per month
Between -13°, and -32°, 15 " " "
Not lower than -20°, 11 " " "
Zero or lower, but above -14°, 5 " " "
Below -46°, 1 day in 3 months
Data from reference (5)

Figure 2. Locations of the Weather Stations used in this Study
(See Table VII for Names of Stations)

Figure 3, we have the January adjusted daily minimum probability scale (Fig. 4).

3. Validation of the Scale

It was assumed that the adjusted scale (Fig. 4) ought to reflect well the actual frequencies of the ten component stations (data in Table I and locations in Fig. 2 as □). How well it did serve is shown in Table II. For example: at Aklavik, as shown in Table I, the actual daily minima five days per month (January, 341-day record) were -45°F or lower. This was 2F° lower than the adjusted scale indicated (-43°F). The other differences at Aklavik were less than 2F°. Table II records the differences for each of the other component stations. It should be noted that the reliability is good for the lower temperatures of the scale with the exception of Barrow. This anomaly is due to the extreme isolation (10°F) of the two lowest minima from the nearest associated minima*. In general, the departure of the actual from the probable up to 25 days per month is not large.

To test further the validity of the adjusted scale, ten check stations (essential data in Table III, location shown in Figure 2 as large circles), for which frequency distributions were available, were utilized. How well the adjusted scale reflects the actual frequencies for the ten check stations is shown in Table IV. Perhaps surprisingly (since the scale was constructed from averages of the component stations), the agreement of the probable minima with the actual minima for the check stations is nearly as good as that for the component stations (Table II).

The data in Tables II and IV were combined to construct Table V. Out of 200 measurements of January daily minima for the 20 stations at ten different percentile levels, less than 5% of the scaled values differ from the actual by more than 5F°. The scale becomes progressively less reliable beyond the 95-percentile ordinate.

It should be noted again that the construction of the adjusted scale was based on actual temperature frequencies of approximately ten consecutive Januarys. It is apparent, however, that the scale should provide an adjustment for abbreviated records of longer than ten years. The following section shows how this may be done.

4. Scale Adjustments for Length of Record

It is assumed in general that long temperature records have lower absolute minima than short records do. To test this assumption, the records of January extreme minima at 24 stations in the United States, each with at least a 70-year record, were used. These stations and their records of

---

*The two lowest minima were -56°F and -55°F, respectively. The third lowest was -45°F, an isolation of 10F°.

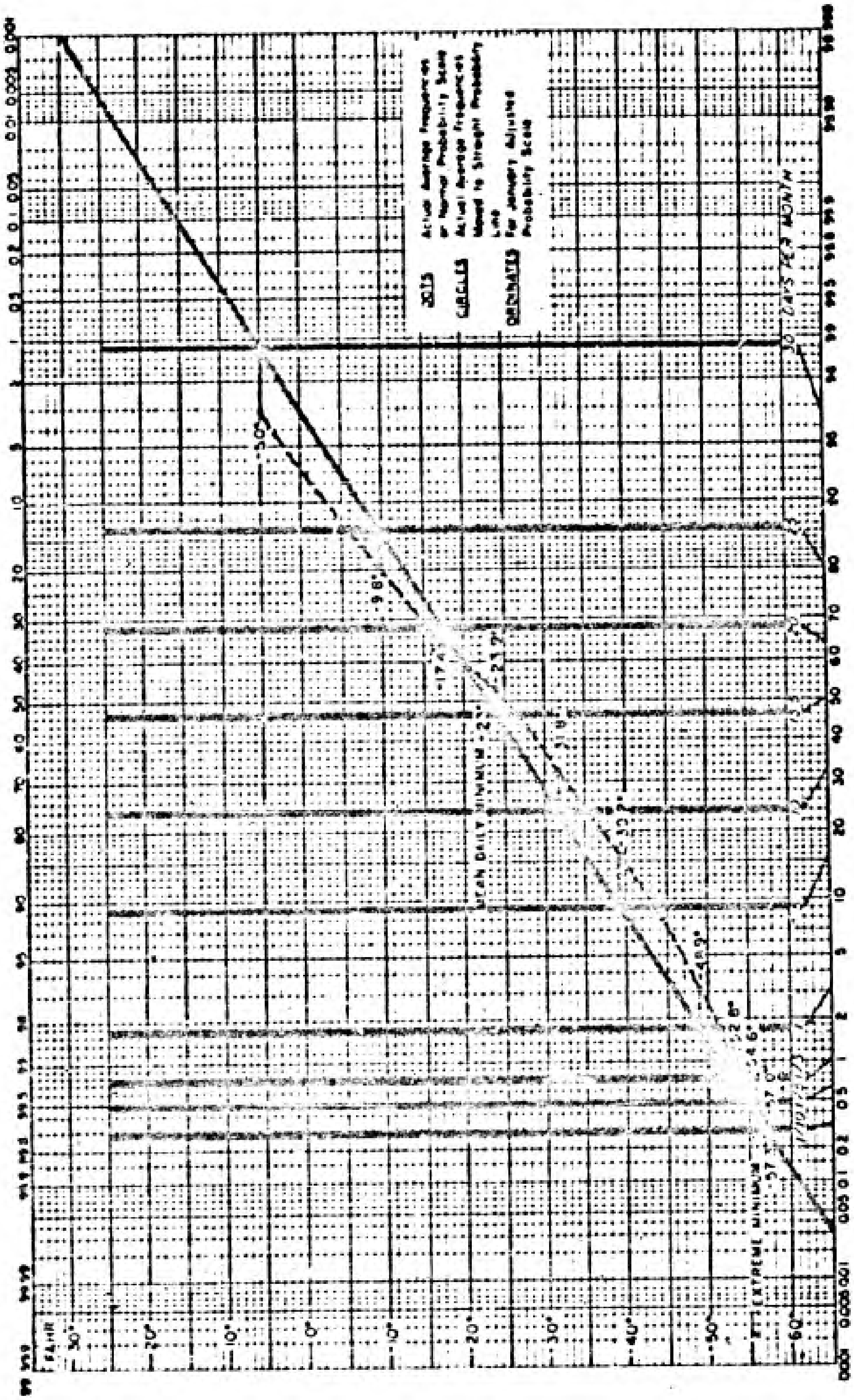

Figure 3. Construction of a January Adjusted Temperature Probability Scale for Northern North America

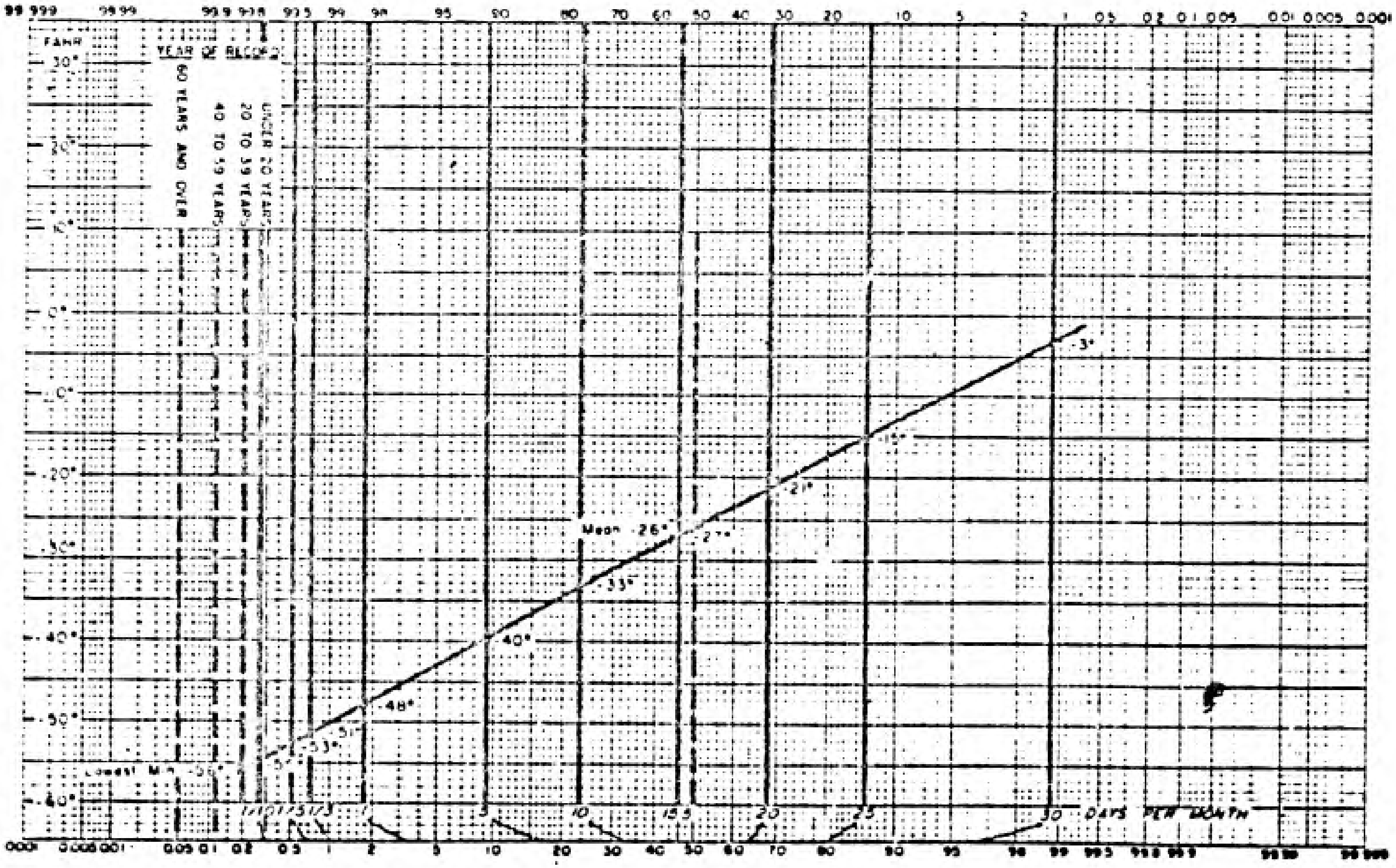

Figure 4. January Adjusted Daily Minimum Temperature Probability Scale for Northern North America (days per month)

Table II: Departure (in °F) of actual January daily minimum temperatures from minima estimated on adjusted probability scale (Fig. 4) for selected number of days per month for ten component stations, [illegible] North America

COMPONENT STATIONS	Differences in F° between Daily Minimum Probabilities and Actual Frequency Values*									
	30 (96.8)	25 (80.6)	20 (64.5)	15.5 (50.0)	10 (32.2)	5 (16.1)	1 (3.2)	1/3 (1.1)	1/5 (0.65)	1/10 (0.32)
CANADA										
Aklavik	+1	0	0	0	-1	-2	-1	-1	-1	0
Churchill	+4	+1	-1	-2	-1	-0	-1	-1	-1	0
Coppermine	+0	-1	-1	-2	0	+1	+1	+1	0	+1
Dawson	-4	+2	+2	+2	0	+1	0	+1	-1	0
Ft. Smith	-3	-2	-1	+1	0	0	-1	0	0	+1
Pangnirtung	+12	+1	-3	-1	-2	-2	-2	0	0	0
Pond Inlet	+5	+2	0	0	-3	-2	-2	-1	-1	-1
ALASKA										
Barrow	+4	-2	0	0	+2	+4	+6	+7	+7	+1
Kotzebue	-2	0	+1	-1	+1	+2	-1	-2	-2	0
Tanana	-11	-3	+1	+4	+5	+4	+1	+2	+1	+3

*Plus (+) indicates that the recorded temperatures were higher than those indicated by the probability scale (Fig. 4), and minus (-) indicates that the recorded values were lower. Figures in parentheses represent percent the number of days is of total

Table III: Frequencies of Specified January Daily Minimum Temperatures (°F) at 10 Check Stations, Northern North America

CHECK STATIONS	Essential Data: Mean Daily Min.	Essential Data: Absolute Min.	Essential Data: No. of Days in Record	Actual Frequencies in Percentages and days per month with given minimum or lower*: 30 (96.8)	25 (80.6)	20 (64.5)	15.5 (50.0)	10 (32.2)	5 (16.1)	1 (3.2)	1/3 (1.1)	1/5 (0.65)	1/10 (0.32)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
CANADA													
Chesterfield	-32.2	-60	310	-4	-17	-27	-33	-40	-46	-55	-59	-60	-62
Ft. Good Hope	-30.4	-64	410	0	-15	-22	-31	-41	-50	-58	-62	-63	-64
Ft. Simpson	-21.2	-66	401	+2	-10	-17	-23	-31	-41	-56	-64	-65	-66
Mayo Landing	-23.0	-66	434	+16	-2	-14	-24	-36	-47	-59	-64	-66	-67
Port Harrison	-21.2	-45	156	-4	-12	-19	-24	-29	-35	-41	-44	-45	-46
Resolution Is.	-6.5	-30	279	+19	+3	-3	-8	-13	-20	-26	-30	-32	-33
ALASKA													
Ft. Yukon	-25.8	-66	399	+4	-10	-17	-24	-34	-47	-56	-58	-65	-67
Bettel	-0.4	-46	455	31	18	8	-1	-11	-23	-35	-40	-42	-46
Nome	-0.5	-37	463	28	16	6	-1	-6	-19	-32	-34	-36	-37
Anchorage	+9.1	-27	453	29	20	15	9	+2	-6	-16	-20	-23	-27

*Figures in parentheses represent percent number of days is of total.

Table IV: Departure (in °F) of actual January daily minimum temperatures from minima estimated on adjusted probability scale (Fig. 4) for selected number of days per month for ten check stations

CHECK STATIONS	Differences in F° between Daily Minimum Probabilities and Actual Frequency Values*									
CANADA	30 (96.8)	25 (80.6)	20 (64.5)	15.5 (50.0)	10 (32.2)	5 (16.1)	1 (3.2)	1/3 (1.1)	1/5 (0.65)	1/10 (0.32)
Chesterfield	+5	+4	0	0	-1	0	-1	-2	-2	-1
Ft. Good Hope	+3	+2	+3	+1	-2	-3	-1	-2	-1	0
Ft. Simpson	-14	-6	-3	-1	+2	+2	0	-3	-2	+1
Mayo Landing	+3	+4	+2	0	-2	-3	-3	-3	-3	-1
Port Harrison	+4	-1	-2	-2	-1	-1	+1	+1	+1	+2
Resolution Is.	+7	0	0	0	0	-2	-1	-2	-3	-2
ALASKA										
Fort Yukon	-3	0	+2	+3	+2	-2	+1	0	-2	-1
Bethel	0	+1	+1	0	+1	-1	-1	-1	-1	-1
Nome	-2	+2	0	0	-1	-1	-4	-2	-3	-1
Anchorage	-3	-1	+1	+2	+3	+3	+3	+3	+2	0

*Plus (+) indicates that the recorded temperatures were higher than those indicated by the probability scale (Fig. 4), and minus (-) indicates that the recorded values were lower. Figures in parentheses represent percent the number of days is of total

Table V: Frequency Departure (F°, + or -) of Actual Minima from the Estimated at 10 Levels (percentage and days). 10 Component and 10 Check Stations Combined

% of Time	Days per Month	Actual Temperatures Below Probable (Frequencies) Actual Temperatures Above Probable																											No. of Sta-tions
		-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10	-11	+12	
96.44	30	1			1							1	2	2		1	3		2	1	3	1		1				1	20
80.6	25									1			1	2	1	5	2	4	2	2									20
64.5	20												2		3	8	3	3	1										20
50.0	15.5													2	4	7	4	1	1	1									20
32.2	10												1	3	4	5	1	5			1								20
16.1	5											1	1	5	3	3	2	2	1	1	1								20
3.2	1												1	2	9	3	3		1				1						20
1.1	1/3												4	3	5	4	2	1						1					20
0.65	1/5												2	4	7	3	2	1						1					20
0.32	1/10													1	4	8	6		1										20
Freq. Totals		1			1					1		2	14	24	40	47	28	17	9	5	5	1	1	3				1	20 200
Freq. in Percent		0.5			0.5					0.5		1.0	7.0	12.0	20.0	23.5	14.0	8.5	4.5	2.5	2.5	0.5	0.5	1.5				0.5	100

For Example: For the 20 stations, the probabilities are that 20 days per month (see 20-day line) the actual minimum will be 3F° below (-3F°) the probable minimum at two stations; 1F° below (-1F°) at three stations; no difference at eight stations; 1F° above (+1F°) at three stations; 2F° above (+2F°) at three stations; and 3F° above (+3F°) at one station.

Comments: The overall performance of the January daily minimum probability scale is reflected in the last line of the table. For 23.5% of the 200 estimates, the actual minima did not differ from the scaled values; 57.5% by not more than 1F°; 78.0% by not more than 2F°; 89.5% by not more than 3F°; 93.0% by not more than 4F°; and 95.5% by not more than 5F°. Reliability is low beyond the 95 percentile (1st column).

absolute minima by ten-year accretions are shown in Table VI. For example: at Peoria, Illinois, the lowest temperature in the 70 years (seven decades) preceding 1951 was -27°F. The absolute minima by decades for the other 24 stations are similarly recorded.

The averages of the absolute minima of the 24 stations for each of the decade intervals are shown in the "Averages" line, Table VI. On the whole, the absolute minimum dropped about 1°F for each decade accretion: 7.9°F for seven decades. The averages of these series of absolute minima, together with the averages of the 24 mean daily minima (next to last column) deter- mined the positions of the four plotting ordinates shown at far left in Figure 4.. They are spaces for 310*, 930, 1550, and 2170 observations of daily minima - the number of January days in 10, 30, 50, and 70 years, re- spectively. These four special ordinates will enable one to locate on the scale the approximate position of the lowest minimum January temperature records running back to 70 years or more.

5. Areal values derived from the January Adjusted Probability Scale

By use of the adjusted scale (Fig. 4), and the three items of essen- tial data (Table VII) for each station, the probable daily minima for speci- fied days per month at the 71 stations in northern North America were de- rived (Table VII). For example: if a temperature scale is supplied at the left margin of Fig. 4 for Aklavik (Table VII) and the essential items of data are plotted (-26°F on the 50° percentile, -56°F on the 22-year ordinate, and a straight line drawn through the two points), then the daily minimum temperatures registered at the intersection of the designated ordinates and the oblique line, or a lower temperature, may be expected. The results approximate closely those recorded from the 341-day frequency record (Table I).

By consulting Table VII, one can find the probable number of January days at any of the 71 stations that the daily minimum may fall to or below a given temperature, or, conversely, the daily minimum or lower which should be expected in a given number of days.

6. January Daily Minima Series of Maps for Northern North America

The probable daily minimum temperatures for the 71 weather stations shown in Table VII can be used in constructing daily minima probability maps. For example, when the temperatures in the 25-days-per-month column are en- tered on a map and isotherms are drawn at 10°F intervals, Figure 5 results. This map shows that for 25 days in January the probable daily minimum in the

---

*Since the 10-January daily minimum ordinate was basic to the construction of the adjusted probability scale (Fig. 4), it also served as the reference ordinate in the positioning of the four special ordinates for length of record.

2

Table VI: Lowest January Temperatures (°F) by 10-year Accretions up to 1950

STATIONS	70 (1881-)	60 (1891-)	50 (1901-)	40 (1911-)	30 (1921-)	20 (1931-)	10 (1941-1950)	Mean Daily Min.*	Differences** (F°)
Abilene, Tex.	-9	-9	-9	-9	-9	-9	-9	33.1	0
Albany, N.Y.	-24	-24	-24	-21	-21	-21	-21	15.5	3
Amarillo, Tex.	-11	-11	-11	-11	-8	-7	-7	24.3	4
Birmingham, Ala.	+1	+1	+1	+1	+1	+1	+7	37.3	6
Boise, Idaho	-28	-17	-17	-17	-17	-17	-17	21.6	11
Boston, Mass.	-13	-10	-9	-9	-6	-3	-3	20.4	10
Denver, Colo.	-21	-21	-21	-21	-20	-15	-14	17.8	7
Detroit, Mich.	-16	-16	-16	-16	-9	-9	-6	18.1	10
Flagstaff, Ariz.	-25	-25	-25	-25	-20	-20	+20	14.2	5
Fort Smith, Ark.	-11	-11	-11	-11	-9	0	+1	29.9	12
Havre, Mont.	-57	-57	-57	-57	-39	-39	-39	2.7	18
Lander, Wyo.	-39	-39	-39	-39	-39	-36	-36	5.4	3
Lincoln, Nebr.	-29	-29	-26	-26	-19	-19	-18	14.2	11
Miami, Fla.	+29	+29	+29	+31	+31	+31	+41	62.1	12
New Orleans, La.	+17	+17	+17	+17	+19	+21	+21	47.0	4
Peoria, Ill.	-27	-21	-21	-21	-20	-20	-12	17.1	15
Pittsburgh, Pa.	-9	-9	-9	-9	-9	-9	-2	23.3	7
Raleigh, N.C.	+2	+2	+6	+6	+6	+6	+6	32.8	4
Red Bluff, Cal.	+17	+17	+17	+17	+17	+17	+20	37.6	3
St. Paul, Minn.	-36	-33	-33	-31	-31	-31	-26	3.1	10
Salt Lake City, Utah	-22	-22	-22	-22	-22	-22	-22	21.9	0
Seattle, Wash.	-3	+3	+11	+11	+11	+11	+11	35.4	14
Wichita, Kans.	-14	-14	-14	-14	-14	-12	-10	22.4	4
Williston, N.D.	-49	-42	-42	-42	-38	-38	-37	-3.5	12
Averages	-16.7	-14.2	-13.5	-13.3	-11	-10	-8.8	23.1	7.9
No. of Days	2170	1860	1550	1240	930	620	310		
Reciprocals of No. of Days	.046	.054	.065	.081	.11	.16	.32		

(Basic data from Climatic Summary Bulletin W, U.S. Weather Bureau Govt. Printing Office, Washington, D.C.)

*50-years (1881-1930 January Mean Daily Minimum Temperatures)

**Difference between the January absolute minimum during the last decade listed (1941-1950) and during the entire 70-year period

Table VII: January Daily Minimum Temperature Probabilities at 71 Stations
(Determined by use of an adjusted probability scale (Fig. 4)

No. on Map	Weather Stations	Essential Data Mean Daily Min.	Absolute Min.	Number Yrs.	Days per Month with Indicated Probable Minima or Lower 30 (96.8)*	25 (80.6)	20 (64.5)	15.5 (50.0)	10 (32.3)	5 (16.1)	1 (3.2)	1/3 (1.1)	1/5 (0.65)	1/10 (0.32)
	ALASKA													
7	Anchorage	6	-35	33	30	22	13	5	-4	-13	-24	-28	-30	-34
26	Annette Is.	30	-4	15	50	42	36	29	21	13	4	0	-2	-5
15	Barrow	-22	-53	35	-2	-10	-17	-23	-29	-36	-46	-48	-49	-52
4	Bethel	-1	-52	32	30	18	7	-2	-13	-24	-38	-43	-46	-50
20	Copper Center	-27	-74	15	22	-1	-13	-23	-35	-48	-63	-67	-69	-74
21	Cordova	18	-27	11	50	35	25	17	6	-4	-17	-22	-24	-27
5	Dutch Harbor	28	-10	19	42	35	31	28	23	19	14	12	11	9
18	Eagle	-23	-75	35	17	-4	-15	-24	-36	-47	-61	-66	-69	-73
17	Fairbanks	-19	-66	26	17	-2	-12	-20	-33	-40	-53	-58	-60	-64
14	Ft. Yukon	-27	-67	27	4	-12	-21	-30	-37	-46	-57	-61	-63	-66
11	Galena	-20	-64	5	17	-2	-12	-21	-31	-41	-54	-59	-61	-64
1	Gambell	0	-23	10	19	9	4	0	-6	-11	-18	-21	-22	-26
8	Holy Cross	-5	-60	10	34	13	3	-6	-17	-28	-42	-47	-49	-53
25	Juneau	24	-15	17	52	37	30	23	15	7	-3	-7	-9	-12
27	[illegible]	-3	-39	29	25	10	3	-4	-12	-20	-27	-33	-36	-38
6	Kodiak	26	-9	49	50	37	31	25	18	11	2	-2	-3	-6
2	Kotzebue	-14	-43	13	10	-3	-9	-15	-22	-28	-37	-40	-44	-44
10	McGrath	-18	-64	15	19	-1	-11	-20	-30	-40	-54	-59	-61	-65
19	McKinley Pk.	-7	-52	19	31	11	1	-8	-19	-29	-42	-47	-49	-53
3	Nome	-2	-49	30	34	15	5	-3	-13	-23	-35	-41	-43	-46
23	St. Paul Is.	23	-14	34	50	39	30	22	11	0	-13	-18	-20	-24
9	Talkeetna	-3	-48	23	32	14	4	-4	-14	-24	-35	-41	-43	-46
12	Tanana	-21	-76	40	20	-2	-13	-22	-34	-45	-60	-65	-67	-70
14	Umiat	-31	-52	5	-6	-19	-26	-32	-39	-46	-55	-59	-60	-62
13	Wiseman	-21	-62	7	12	-5	-14	-22	-31	-41	-52	-57	-59	-62
24	Yakutat	20	-22	8	50	36	27	19	9	0	-13	-17	-19	-23
	CANADA													
27	Aklavik	-26	-56	22	-3	-15	-21	-27	-33	-40	-48	-51	-53	-55
16	Alert	-35	-54	4	-21	-29	-33	-36	-41	-45	-50	-52	-53	-55
55	Arctic Bay	-28	-52	13	-8	-18	-24	-29	-34	-40	-48	-50	-51	-53
39	Cambridge Bay	-33	-63	14	-9	-22	-28	-34	-41	-48	-56	-58	-61	-63

*Figures in parentheses represent percent number of days is of total

Table VII (Continued)

No. on Map	WEATHER STATIONS	Essential Data: Mean Daily Min.	Essential Data: Absolute Min.	Essential Data: Number Yrs.	Days per Month with Indicated Probable Minima or Lower: 30 (96.8)*	25 (80.6)	20 (64.5)	15.5 (50.0)	10 (32.3)	5 (16.1)	1 (3.2)	1/3 (1.1)	1/5 (0.65)	1/10 (0.32)
	CANADA (contd)													
50	Cape Hope Adv.	-13	-34	8	+4	-5	-10	-14	-19	-23	-29	-32	-33	-34
31	Carcross	-10	-60	31	29	8	-2	-11	-22	-32	-46	-52	-54	-58
43	Chesterfield	-32	-60	29	-10	-22	-28	-33	-39	-45	-52	-55	-57	-59
42	Churchill	-27	-57	30	-4	-16	-22	-28	-34	-45	-49	-52	-53	-55
54	Clyde	-24	-42	11	-9	-17	-21	-25	-29	-33	-38	-40	-41	-42
35	Coppermine	-26	-54	19	-3	-15	-21	-26	-33	-40	-48	-51	-52	-54
29	Dawson	-23	-66	41	0	-15	-22	-25	-37	-45	-55	-59	-60	-63
45	Eureka	-44	-60	7	-31	-38	-42	-45	-48	-52	-57	-58	-59	-60
41	Fond du Lac	-27	-61	24	-1	-15	-22	-28	-35	-42	-52	-55	-57	-60
49	Fort Chimo	-21	-50	12	+4	-9	-16	-21	-28	-35	-43	-47	-48	-51
28	Ft. Good Hope	-33	-67	31	-6	-21	-28	-34	-41	-48	-58	-62	-63	-65
32	Fort Nelson	-14	-61	13	+25	+5	-6	-15	-26	-37	-50	-56	-58	-62
34	Fort Norman	-27	-62	31	0	-14	-22	-28	-35	-43	-52	-57	-58	-60
33	Fort Simpson	-23	-66	27	10	-7	-17	-24	-34	-43	-55	-59	-61	-64
40	Fort Smith	-22	-64	30	11	-6	-15	-23	-32	-41	-52	-57	-59	-61
36	Holman Is.	-23	-45	10	-4	-14	-19	-23	-29	-34	-40	-43	-44	-46
38	Isachsen	-40	-63	6	-21	-31	-36	-41	-46	-51	-59	-60	-62	-64
52	Lake Harbor	-21	-45	22	-2	-12	-17	-21	-27	-32	-33	-41	-42	-44
30	Mayo Landing	-20	-73	26	22	0	-11	-21	-33	-45	-59	-65	-67	-70
37	Mould Bay	-37	-63	6	-15	-26	-32	-37	-44	-50	-57	-60	-62	-64
47	Nottingham Is.	-19	-40	21	-2	-11	-15	-19	-34	-29	-35	-38	-39	-41
53	Pangnirtung	-23	-46	13	-5	-14	-20	-24	-29	-34	-41	-44	-45	-47
56	Pond Inlet	-32	-56	21	-14	-23	-28	-33	-38	-43	-49	-52	-53	-55
48	Port Harrison	-22	-51	29	+1	-11	-17	-22	-29	-35	-43	-46	-47	-50
51	Resolution Is.	-6	-35	19	19	6	-1	-7	-14	-21	-30	-33	-35	-37
	GREENLAND													
65	Angmagssalik	10	-23	35	36	22	15	9	+2	-5	-14	-17	-19	-22
67	Central Station	-43	-67	2	-23	-33	-39	-44	-47	-55	-62	-64	-65	-68
69	Danmarks Havn	-14	-33	2	+2	-6	-11	-14	-19	-23	-29	-31	-32	-34

*Figures in parentheses represent percent number of days is of total

Table VII (Continued)

No. on Map	WEATHER STATIONS	[illegible] Data			Days per Month with Indicated Probable Minima or Lower									
		Mean Daily Min.	Absolute Min.	Number Yrs.	30 (96.8)*	25 (80.6)	20 (64.5)	15.5 (50.0)	10 (32.3)	5 (16.1)	1 (3.2)	1/3 (1.1)	1/5 (0.65)	1/10 (0.32)
	<u>GREENLAND</u>													
66	Eismitte	-53	-64	1	-28	-41	-48	-54	-61	-68	-77	-80	-82	-84
59	Godhavn	6	-25	13	34	19	12	5	-3	-10	-20	-24	-26	-28
61	Godthaab	10	-20	50	32	20	14	9	+3	-3	-11	-14	-15	-17
62	Ivigtut	12	-18	50	34	22	14	11	+5	-1	-9	-12	-13	-15
60	Jakobshavn	-7	-45	50	21	7	-1	-8	-16	-24	-33	-37	-39	-42
63	Nanortalik	17	4	11	28	22	19	17	14	11	7	6	5	4
70	Nord	-28	-49	4	-10	-20	-24	-29	-33	-38	-44	-47	-48	-50
68	Scoresbysund	-3	-37	10	25	10	+3	-4	-12	-20	-29	-33	-35	-38
58	Upernavik	-13	-39	48	+6	-6	-10	-14	-19	-25	-31	-34	-35	-37
57	Thule	-20	-37	6	-6	-13	-17	-20	-25	-28	-33	-35	-36	-38
	<u>ICELAND</u>													
72	Akureyri	25	-1	10	46	35	29	24	18	12	5	2	+1	-2
71	Reykjavik	27	6	11	45	35	31	27	22	17	11	8	7	5
73	Tiegarhorn	25	-14	59	53	39	31	25	16	8	-2	-6	-8	-10

*Figures in parentheses represent percent number of days in of total

vicinity of Eureka, Canada (Fig. 2, No. 45) is -30°F or lower. Since this is a 25-day map, the daily minimum temperatures or lower, as indicated by the isotherms in different parts of the area, should be expected.

Two other maps are shown in this series, and each should be read in the same way that Figure 5 was read. Figure 6 indicates areal distribution of January daily minima or lower that may be expected ten days per month; and Figure 7, 1 day in 3 Januarys (1/3 per month).

7. Another type (Percentage of Days) of January Minumum Temperature Probability Scale

If one wanted to construct a map of northern North America showing the frequency occurrence of a January daily minimum temperature of -20°F or lower, it would be difficult to extract the needed information from Table VII. This table features only ten percentage levels, and these are all fractional (96.8 80.6%, etc.). The scale constructed below has 39 percentage levels (ordinates), and they are all integral except the four extremes (Figure 8).

a. Constructing the Scale

An adjusted probability scale featuring percentage of days for given January minimum temperature levels can be derived from the temperature frequencies (tabulations by Parmele) used in the foregoing study. The frequency tabulations used in constructing Table I also were used as the basis for Table VIII. From the averages in the last line of this table, Figure 8 was derived - an adjusted probability scale for finding daily minimum temperatures in percentage of days. This scale can be validated by use of the check stations listed in Table III. The same adjustment for length of record as utilized in Figure 4 may be used for Figure 8.

Now, the essential data for the 71 stations in Table VII may be plotted on this percentage probability scale (Fig. 8), and a set of 39 January daily minimum temperature probabilities derived for each station (Table IX). Other percentage probabilities may be interpolated. Percentage frequencies can be easily translated into days per month.

b. Construction and Use of Maps

From the tabulated data in this table one can draw a map of northern North America showing the percentage of January days on which the daily minimum temperature falls to a specified level or lower. For example, suppose a sleeping bag is designed to give adequate protection down to -20°F. The map (Fig. 9) indicates just where in northern North America these critical minima (-20°F and below) may be expected in January and the percentage of January days when the daily minima fall to or below the critical temperature of -20°F. At Churchill in January a man in this sleeping bag would need added protection from daily minima about 70% of the time (22 days per month). It may be seen from the table that 5% of the time (2 days) at

Figure 5. Probable Daily Minimum Temperature 25 Days per January

Figure 6. Probable Daily Minimum Temperatures 10 Days per January

Figure 7. Probable Daily Minimum Temperatures 1 Day in 3 Januarys

Table VIII: Frequencies by percentages of specified January daily minimum temperatures (°F) at 10 component stations

Map No.	Stations	Percentage of Time with Indicated Daily Minimum Temperatures or Lower																			
		0.1	0.5	1	2	3	4	5	6	7	8	9	10	15	20	25	30	35	40	45	50
	Canada																				
27	Aklavik	[illegible]	-56	-54	-54	-53	-52	-51	[illegible]	-50	[illegible]	[illegible]	[illegible]	[illegible]	-43	-40	[illegible]	-36	-33	-31	-29
42	Churchill	-50	-49	-47	-46	-45	-44	-43	-42	-41	-40	-39	-38	-35	-34	-33	-32	-30	-29	-28	-27
35	Coppermine	-55	-54	-50	-48	-47	-46	-45	-44	-44	-43	-43	-42	-37	-37	-35	-34	[illegible]	[illegible]	-29	-28
29	Dawson	-66	-65	-63	-62	-60	-57	-55	-54	-53	-52	-51	-51	-47	-44	-39	-36	[illegible]	[illegible]	-28	-24
40	Ft. Smith	-63	-62	-60	-57	-55	-54	-52	-51	-50	-49	-49	-47	-44	-41	-38	-35	-31	-28	-26	-24
53	Pangnirtung	-47	-45	-44	-43	-42	-41	-41	-40	-40	-39	-39	-36	-35	-35	-32	-30	-29	-27	-25	-23
56	Pond Inlet	-57	-56	-55	-54	-53	-53	-52	-51	-51	-50	-50	-49	-47	-46	-43	-41	-39	-37	-35	-33
	Alaska																				
15	Barrow	-56	-55	-44	-42	-40	-39	-38	-37	-36	-36	-35	-35	-33	-30	-28	-27	-25	-23	-21	-20
2	Kotzebue	-56	-55	-53	-45	-43	-42	-41	-40	-39	-38	-37	-36	-33	-31	-28	-25	-22	-20	-19	-16
12	Tanana	[illegible]	-65	-62	-60	-56	-55	-54	-52	-50	-49	-46	-45	-37	-34	-32	-27	-24	-20	-18	-15
	Averages	-57.6	-56.0	-53.2	-51.1	-49.4	-48.3	-47.2	-46.1	-45.4	-44.5	-43.7	-42.4	-40.0	-37.2	-34.6	-32.6	-30.1	-27.8	-25.9	-23.9

Map No.	Stations	Percentage of Time with Indicated Daily Minimum Temperatures or Lower																			
		50	55	60	65	70	75	80	85	90	91	92	93	94	95	96	97	98	99	99.5	99.9
	Canada																				
27	Aklavik	-29	-26	-24	-22	-21	-19	-15	-13	-11	-10	-8	-7	-5	-4	-3	-2	0	+4	+6	+8
42	Churchill	-27	-25	-24	-22	-19	-17	-14	-11	-8	-7	-6	-5	-4	-3	-2	0	+2	+6	+14	+20
35	Coppermine	-28	-26	-24	-22	-21	-19	-16	-13	-10	-9	-7	-6	-5	-4	-3	-2	-1	0	+6	+9
29	Dawson	-24	-22	-19	-16	-14	-11	-7	-4	0	+1	+1	+2	+2	+3	+4	+6	+8	+10	+18	+19
40	Ft. Smith	-24	-21	-19	-17	-14	-12	-10	-6	-3	-2	+1	+2	+3	+4	+5	+7	+10	+14	+20	+24
53	Pangnirtung	-23	-22	-21	-19	-17	-14	-10	-6	-2	0	+1	+3	+4	+6	+8	+12	+16	+24	+27	+30
56	Pond Inlet	-33	-31	-30	-28	-26	-24	-21	-18	-14	-12	-11	-10	-9	-8	-7	-6	-5	-4	+2	+4
	Alaska																				
15	Barrow	-20	-18	-15	-12	-10	-5	-7	-4	-1	0	+1	+2	+4	+5	+6	+7	+8	+9	+15	+24
8	Kotzebue	-16	-13	-10	-6	-3	-0	+2	+7	+10	+12	+13	+14	+15	+17	+18	+19	+21	+22	+24	+29
12	Tanana	-15	-12	-10	-8	-5	-3	-1	+1	+5	+6	+7	+8	+10	+11	+12	+13	+21	+23	+28	+30
	Averages	-23.9	-21.6	-19.6	-17.2	-15.0	-12.7	-10.3	-6.5	-3.4	-2.1	-0.8	+0.3	+1.5	+2.7	+3.8	+5.4	+8.0	+10.8	+16.0	+19.7

Basic data from tabulation by Owen Parmele, formerly of QM R&E Command

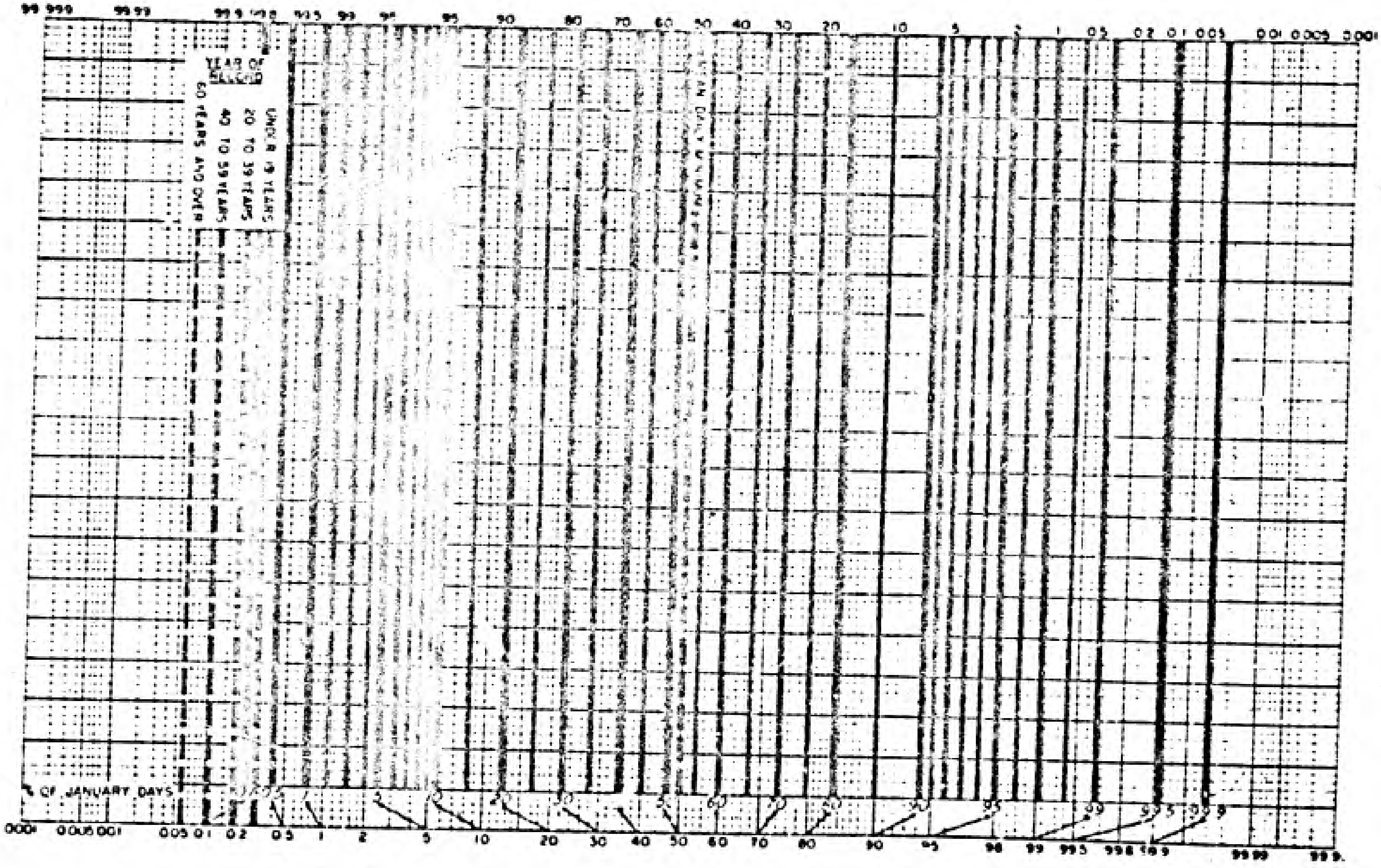

Figure 8. January Adjusted Daily Minimum Temperature Probability Scale for Northern North America (Percentage of Days)

Table 12: January Daily Minimum Temperature (°F) Probabilities for 71 Stations
(Determined by Use of an Adjusted Probability Scale. See Figure 8)

PERCENTAGE OF DAYS*

Map No.	Stations	99.9 0.1	99.5 0.5	99 1	98 2	97 3	96 4	95 5	94 6	93 7	92 8	91 9	90 10	85 15	80 20	75 25	70 30	65 35	60 40	55 45	50 50	45 55	40 60	35 65	30 70	25 75	20 80	15 85	10 90	9 91	8 92	7 93	6 94	5 95	4 96	3 97	2 98	1 99	0.5 99.5	0.1 99.9
	ALASKA																																							
7	Anchorage	-36	-32	-29	-26	-24	-23	-22	-20	-19	-18	-18	-17	-13	-10	-7	-5	-2	0	3	5	7	10	12	15	17	20	24	28	29	30	32	33	35	37	38	41	44	49	52
26	Annette Island	-5	-3	0	2	3	5	6	7	8	9	10	11	13	16	18	21	23	25	27	29	31	33	36	38	40	43	46	50	51	52	53	54	55	57	59	61	64	69	73
15	Barrow	-52	-50	-48	-46	-45	-44	-43	-42	-41	-40	-40	-39	-38	-37	-36	-30	-28	-26	-24	-23	-21	-19	-17	-15	-13	-11	-8	-5	-4	-3	-2	-1	0	2	3	5	7	12	18
4	Bethel	-61	-48	-44	-41	-38	-37	-35	-33	-32	-31	-29	-28	-24	-20	-16	-13	-9	-6	-3	0	2	7	9	13	16	19	24	30	31	33	35	37	38	42	46	47	50	54	60
20	Copper Center	-76	-72	-68	-65	-63	-61	-59	-57	-56	-55	-53	-52	-48	-43	-40	-36	-33	-29	-26	-23	-20	-17	-13	-10	-6	-3	2	8	10	11	13	15	17	20	23	25	29	38	46
21	Cordova	-27	-25	-20	-19	-17	-15	-14	-13	-11	-10	-9	-8	-5	-1	3	5	9	12	14	17	20	23	25	28	30	35	39	44	45	46	48	50	52	54	56	59	62	69	76
5	Dutch Harbor	9	11	12	13	14	14	15	15	16	17	17	18	19	20	22	23	24	25	27	28	29	30	31	33	34	35	37	38	38	40	40	41	42	43	44	45	46	49	51
18	Eagle	-73	-70	-67	-64	-62	-60	-59	-57	-56	-54	-53	-52	-48	-44	-40	-37	-33	-30	-28	-24	-22	-19	-15	-11	-8	-5	0	5	7	8	10	12	14	17	20	23	28	33	38
17	Fairbanks	-66	-62	-59	-56	-54	-52	-51	-50	-48	-47	-46	-45	-41	-38	-35	-32	-28	-26	-23	-20	-18	-15	-12	-9	-6	-3	1	6	7	8	10	12	14	16	18	23	26	32	38
16	Fort Yukon	-66	-63	-60	-58	-56	-55	-54	-53	-52	-51	-50	-49	-46	-43	-40	-37	-35	-32	-30	-28	-26	-23	-21	-18	-16	-13	-10	-4	-4	-3	-2	-1	1	3	5	7	10	14	20
11	Galena	-65	-60	-59	-56	-54	-53	-51	-50	-49	-47	-46	-45	-42	-38	-35	-32	-29	-26	-23	-21	-18	-16	-11	-10	-7	-4	0	5	6	8	9	11	13	15	18	20	23	30	33
1	Gambell	-26	-22	-20	-19	-18	-17	-16	-16	-15	-14	-14	-13	-12	-10	-8	-7	-5	-3	-2	-1	1	2	4	5	7	8	12	13	14	16	15	16	17	18	20	21	23	28	32
8	Holy Cross	-53	-50	-47	-44	-42	-40	-38	-36	-34	-34	-33	-32	-28	-25	-21	-18	-15	-12	-9	-6	-4	-2	3	6	9	12	16	21	23	26	26	28	30	32	35	38	43	48	52
25	Juneau	-12	-9	-7	-6	-3	-2	-1	0	1	2	3	4	7	10	12	14	17	19	21	23	25	28	30	32	34	37	40	44	45	46	47	48	50	52	54	56	58	63	67
22	Kennecott	-38	-36	-33	-31	-30	-29	-28	-26	-25	-24	-24	-23	-20	-17	-15	-13	-10	-8	-6	-4	-2	0	3	5	7	10	13	17	18	19	20	21	23	25	28	30	34	40	48
6	Kodiak	-6	-4	-2	0	2	3	4	5	6	6	7	8	10	13	15	17	20	22	23	25	27	29	31	33	35	38	42	44	45	46	47	48	49	51	53	55	57	62	67
2	Kotzebue	-46	-42	-40	-38	-37	-36	-35	-34	-33	-32	-31	-30	-28	-26	-24	-22	-20	-18	-16	-15	-13	-11	-9	-7	-5	-3	0	3	4	5	6	7	9	11	13	15	18	22	26
10	McGrath	-66	-62	-60	-58	-56	-53	-50	-49	-48	-47	-46	-44	-40	-37	-34	-31	-27	-25	-23	-19	-17	-14	-11	-7	-4	-1	3	8	9	11	12	14	16	18	21	24	27	33	37
19	McKinley Park	-53	-50	-47	-44	-42	-41	-39	-38	-36	-35	-34	-33	-29	-26	-23	-20	-16	-13	-10	-8	-6	-3	0	4	7	10	14	19	20	22	23	25	27	29	30	34	38	44	48
3	Nome	-47	-45	-42	-39	-37	-35	-34	-32	-31	-30	-29	-28	-24	-21	-17	-14	-11	-8	-6	-4	-2	0	3	6	11	14	18	23	24	25	27	29	31	33	36	38	43	48	52
23	St. Paul Island	-25	-22	-19	-16	-14	-12	-11	-9	-8	-7	-6	-5	-4	3	6	10	13	14	19	22	24	27	30	34	37	40	45	50	51	52	54	56	58	60	63	66	70	75	80
9	Talkeetna	-47	-44	-41	-38	-36	-35	-33	-32	-31	-30	-29	-28	-25	-21	-18	-15	-12	-9	-7	-4	-2	1	4	7	10	12	17	21	22	23	25	27	29	31	34	36	40	43	48
12	Tanana	-70	-68	-65	-62	-60	-58	-57	-56	-54	-53	-52	-50	-46	-42	-38	-35	-31	-28	-25	-22	-19	-16	-13	-9	-6	-3	2	8	9	11	12	14	17	19	22	25	28	35	40
14	Umiat	-63	-61	-58	-57	-55	-54	-53	-52	-51	-51	-50	-49	-47	-44	-42	-40	-37	-35	-34	-32	-30	-28	-26	-24	-22	-20	-17	-14	-13	-12	-12	-10	-8	-7	-5	-3	-2	1	7
13	Wiseman	-63	-60	-57	-55	-53	-51	-50	-49	-47	-46	-45	-44	-41	-38	-35	-32	-29	-27	-25	-20	-19	-17	-14	-11	-8	-5	-2	3	4	5	6	8	10	12	14	17	20	26	30
24	Yakutat	-23	-21	-18	-15	-13	-12	-10	-9	-8	-7	-6	-5	-3	0	3	6	11	14	16	19	21	24	27	30	32	35	39	44	45	46	48	48	51	54	56	58	60	68	73

*Upper line in column heading refers to percentage of days with indicated daily minimum temperature or higher.
Lower line " " " " " " " " " " " " " " lower.

Table 14. (Continued)

PERCENTAGE OF DAYS

Map No.	Stations	99.9 0.1	99.5 0.5	99 1	98 2	97 3	96 4	95 5	94 6	93 7	92 8	91 9	90 10	85 15	80 20	75 25	70 30	65 35	60 40	55 45	50 50	45 55	40 60	35 65	30 70	25 75	20 80	15 85	10 90	9 91	8 92	7 93	6 94	5 95	4 96	3 97	2 98	1 99	0.5 99.5	0.1 99.9
	CANADA																																							
27	Aklavik	-55	-53	-51	-49	-48	-47	-46	-45	-44	-44	-43	-42	-40	-38	-36	-34	-32	-30	-28	-27	-25	-23	-21	-19	-17	-15	-13	-10	-9	-8	-7	-6	-5	-3	-2	0	2	7	9
46	Alert	-55	-54	-52	-51	-50	-50	-49	-48	-48	-47	-47	-46	-45	-44	-42	-42	-40	-39	-38	-37	-35	-34	-33	-32	-30	-29	-28	-26	-25	-24	-23	-23	-23	-22	-21	-20	-18	-15	-13
55	Arctic Bay	-53	-51	-49	-48	-47	-45	-45	-45	-44	-43	-43	-42	-40	-39	-37	-35	-34	-32	-31	-29	-28	-27	-25	-23	-22	-20	-18	-15	-15	-14	-13	-12	-12	-10	-9	-8	-6	-3	0
38	Cambridge Bay	-64	-62	-60	-58	-57	-55	-55	-54	-53	-52	-51	-50	-48	-46	-43	-41	-39	-37	-35	-34	-32	-30	-28	-25	-24	-22	-19	-16	-15	-14	-13	-12	-11	-9	-7	-6	-3	+1	4
31	Carcross	-58	-55	-51	-48	-46	-45	-43	-42	-40	-39	-38	-37	-33	-30	-26	-23	-20	-17	-14	-11	-8	-5	-2	1	4	7	12	17	19	19	21	23	25	27	30	32	36	41	46
43	Chesterfield	-59	-57	-55	-54	-53	-52	-51	-50	-49	-49	-48	-47	-45	-43	-41	-39	-37	-35	-34	-32	-31	-29	-27	-25	-24	-22	-19	-17	-16	-15	-14	-13	-12	-10	-9	-7	-4	-2	1
42	Churchill	-56	-54	-52	-50	-49	-48	-47	-46	-45	-45	-44	-43	-41	-39	-37	-35	-33	-31	-29	-28	-26	-24	-22	-20	-18	-17	-14	-11	-10	-9	-9	-8	-6	-5	-3	-1	+1	5	8
54	Clyde	-42	-41	-40	-39	-38	-37	-37	-36	-36	-35	-35	-34	-33	-31	-30	-29	-27	-26	-25	-24	-23	-22	-21	-19	-18	-17	-15	-13	-13	-12	-12	-11	-10	-9	-8	-7	-4	-2	-2
35	Coppermine	-55	-53	-51	-49	-48	-47	-46	-45	-44	-43	-43	-42	-40	-38	-35	-34	-32	-30	-28	-27	-25	-23	-21	-19	-17	-15	-13	-10	-9	-8	-7	-6	-5	-3	-2	0	2	6	9
29	Dawson	-63	-61	-58	-56	-54	-53	-52	-51	-50	-49	-47	-48	-45	-42	-40	-37	-35	-33	-31	-29	-27	-25	-23	-20	-18	-16	-12	-9	-8	-7	-6	-5	-3	-2	+1	3	5	10	14
45	Eureka	-60	-59	-58	-57	-57	-56	-56	-55	-54	-54	-53	-53	-52	-51	-50	-49	-48	-47	-46	-45	-44	-43	-42	-41	-39	-38	-37	-36	-35	-35	-34	-33	-32	-32	-31	-30	-29	-27	-25
41	Fond du Lac	-60	-58	-55	-53	-52	-51	-50	-49	-48	-47	-46	-45	-43	-40	-38	-36	-34	-33	-30	-28	-26	-24	-22	-19	-17	-15	-12	-9	-7	-6	-6	-5	-3	-2	+1	3	5	10	13
49	Fort Chimo	-50	-49	-47	-45	-43	-42	-41	-40	-40	-38	-38	-37	-35	-33	-31	-29	-27	-25	-23	-22	-20	-18	-16	-14	-12	-10	-8	-5	-4	-3	-2	-2	0	2	4	5	7	12	15
28	Fort Good Hope	-66	-64	-61	-60	-59	-57	-56	-55	-54	-53	-52	-52	-49	-47	-46	-44	-42	-38	-36	-34	-32	-30	-28	-26	-23	-21	-18	-15	-14	-13	-12	-12	-10	-8	-6	-4	-3	3	7
32	Fort Nelson	-62	-59	-55	-53	-51	-49	-47	-46	-45	-43	-42	-41	-38	-34	-30	-27	-24	-21	-18	-15	-11	-10	-6	-3	0	3	8	13	14	15	17	19	21	23	26	29	32	37	43
34	Fort Norman	-61	-59	-57	-53	-48	-46	-45	-44	-43	-42	-42	-42	-41	-40	-39	-37	-36	-32	-30	-28	-26	-24	-22	-20	-17	-15	-12	-8	-7	-6	-5	-4	-3	-2	1	3	5	10	14
33	Fort Simpson	-65	-62	-59	-57	-55	-53	-52	-51	-50	-48	-47	-46	-43	-40	-37	-34	-31	-28	-26	-24	-22	-19	-18	-16	-11	-8	-4	0	1	2	4	5	7	10	12	14	17	24	28
40	Fort Smith	-63	-60	-57	-55	-53	-52	-50	-49	-48	-47	-46	-45	-42	-39	-36	-33	-30	-28	-25	-23	-21	-18	-16	-13	-10	-7	-4	-2	2	3	4	6	8	10	12	14	17	24	28
39	Holman Island	-43	-42	-41	-40	-39	-38	-37	-37	-36	-36	-35	-34	-33	-31	-30	-28	-27	-26	-25	-23	-22	-21	-20	-18	-17	-16	-14	-12	-11	-10	-10	-9	-8	-7	-6	-5	-3	0	2
58	Isachsen	-64	-62	-60	-59	-58	-57	-57	-56	-55	-55	-54	-53	-52	-50	-48	-47	-45	-43	-42	-41	-40	-38	-37	-35	-33	-32	-30	-28	-27	-26	-25	-24	-23	-22	-21	-20	-18	-14	-12
52	Lake Harbour	-44	-43	-42	-40	-39	-38	-37	-37	-36	-35	-35	-34	-32	-32	-29	-27	-26	-24	-23	-22	-20	-19	-17	-16	-14	-13	-11	-8	-7	-7	-6	-5	-4	-3	-2	0	2	5	7
30	Mayo Landing	-72	-70	-65	-63	-60	-58	-57	-55	-54	-52	-51	-50	-46	-42	-38	-34	-31	-27	-24	-22	-19	-15	-13	-8	-5	-2	3	9	11	12	13	16	18	20	23	26	30	36	42
37	Mould Bay	-63	-62	-60	-59	-58	-57	-56	-55	-54	-54	-53	-52	-50	-49	-46	-45	-43	-42	-40	-39	-37	-35	-34	-32	-30	-28	-26	-24	-23	-22	-21	-20	-19	-18	-17	-15	-13	-10	-7
47	Nottingham Island	-40	-39	-38	-37	-36	-35	-34	-33	-33	-32	-32	-31	-30	-28	-26	-25	-23	-22	-21	-19	-18	-17	-16	-14	-13	-11	-9	-7	-7	-6	-5	-4	-4	-2	-2	0	2	5	7
53	Pangnirtung	-47	-45	-43	-42	-41	-40	-39	-39	-38	-38	-37	-36	-34	-32	-31	-29	-28	-26	-25	-23	-22	-21	-19	-17	-16	-14	-12	-10	-9	-9	-8	-7	-6	-5	-3	-2	0	3	5
50	Pond Inlet	-55	-54	-52	-51	-50	-49	-48	-47	-47	-46	-46	-45	-43	-42	-40	-38	-37	-35	-34	-33	-32	-30	-28	-27	-25	-24	-22	-19	-18	-18	-17	-16	-15	-14	-13	-12	-10	-6	-4
48	Port Harrison	-50	-46	-46	-44	-43	-42	-41	-41	-40	-39	-38	-38	-36	-34	-31	-29	-28	-26	-24	-23	-21	-19	-17	-16	-14	-12	-9	-7	-8	-6	-4	-3	-2	0	2	3	5	8	12
51	Resolution Island	-37	-35	-33	-32	-29	-28	-27	-26	-26	-25	-24	-23	-21	-18	-16	-14	-12	-10	-8	-6	-5	-3	-1	+1	3	5	8	11	12	13	14	15	16	18	20	22	24	29	32

Upper line in column heading refers to percentage of days with indicated daily minimum temperatures or higher
Lower line " " " " " " " " " " " " " lower

Table IX: (Continued)

P E R C E N T A G E   O F   D A Y S

Sta. No.		99.9 0.1	99.5 0.5	99 1	98 2	97 3	96 4	95 5	94 6	93 7	92 8	91 9	90 10	85 15	80 20	75 25	70 30	65 35	60 40	55 45	50 50	45 55	40 60	35 65	30 70	25 75	20 80	15 85	10 90	9 91	8 92	7 93	6 94	5 95	4 96	3 97	2 98	1 99
	GREENLAND-ICELAND																																					
65	Angmagssalik	-22	-21	-19	-17	-15	-14	-13	-12	-11	-10	-9	-8	-6	-4	-1	+1	3	6	8	9	11	13	15	18	20	22	25	29	30	31	32	33	34	36	38	40	42
67	Central Station	-67	-66	-64	-63	-62	-61	-60	-59	-59	-58	-57	-56	-55	-53	-51	-50	-48	-46	-45	-43	-42	-39	-37	-36	-35	-34	-32	-30	-29	-28	-27	-26	-25	-24	-23	-22	-20
68	Danmarks Havn	-33	-32	-31	-30	-29	-28	-27	-27	-26	-26	-25	-25	-23	-22	-20	-19	-18	-17	-16	-15	-13	-12	-11	-10	-9	-7	-5	-4	-3	-2	-2	-1	0	1	3	3	4
66	Eismitte	-85	-83	-80	-78	-77	-76	-75	-74	-73	-72	-72	-71	-69	-66	-64	-62	-60	-58	-56	-54	-52	-50	-48	-46	-44	-42	-39	-36	-35	-34	-33	-32	-30	-29	-27	-25	-23
59	Godhavn	-29	-27	-24	-22	-21	-19	-18	-17	-16	-15	-14	-13	-11	-8	-6	-3	-1	+1	3	5	7	9	12	14	15	18	23	25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
61	Godthaab	-18	-16	-14	-12	-11	-10	-9	-8	-7	-7	-6	-5	-3	-1	+1	3	5	7	8	9	11	13	15	17	18	20	23	25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
62	Ivigtut	-15	-14	-12	-11	-10	-9	-8	-7	-6	-5	-5	-4	-1	+1	3	5	6	8	10	11	13	15	16	18	20	22	24	27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
60	Jakobshavn	-42	-40	-37	-35	-34	-33	-32	-30	-29	-28	-28	-27	-24	-21	-19	-17	-16	-12	-10	-8	-6	-4	-2	+1	3	5	9	12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
63	Nanortalik	4	5	6	6	7	7	8	8	9	9	10	10	11	12	13	13	14	15	16	17	17	18	18	20	21	22	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
70	Nord	-50	-48	-47	-46	-45	-44	-43	-43	-42	-42	-41	-40	-38	-37	-35	-34	-32	-31	-30	-29	-27	-26	-24	-23	-22	-20	-18	-16	-15	-15	-14	-13	-12	-11	-10	[illegible]	[illegible]
69	Scoresbysund	-38	-36	-33	-31	-30	-28	-27	-26	-25	-24	-23	-22	-20	-17	-15	-13	-10	-8	-6	-4	-2	+1	3	5	8	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
57	Thule	-38	-37	-36	-34	-34	-33	-32	-32	-31	-31	-30	-30	-29	-27	-26	-25	-24	-23	-22	-21	-19	-18	-17	-16	-15	-14	-12	-10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
58	Upernavik	-37	-35	-34	-32	-31	-31	-30	-29	-28	-28	-27	-27	-25	-23	-21	-20	-18	-16	-15	-14	-12	-11	-9	-7	-6	-4	-2	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
72	Akureyri	-4	0	2	4	5	6	7	8	8	9	9	10	12	14	16	18	20	21	23	24	26	27	29	31	33	34	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
71	Reykjavik	5	7	8	10	11	11	12	13	13	14	14	14	17	18	20	21	23	24	25	26	28	29	31	32	33	35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
73	Teigarhorn	-11	-9	-6	-4	-4	-3	0	1	2	3	4	6	8	10	13	15	18	20	22	24	26	28	30	33	36	38	41	44	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Examples: (1) What are the chances at Ivigtut in January for daily minima at or below zero? Ans. 15% or about 5 days. At Upernavik? At Thule? At Teigarhorn?
(2) What are the chances at Ivigtut that the January daily minima will not fall below 32°F? Ans. 5%. At Nanortalik? At Reykjavik?
(3) How low may the January daily minima be expected to fall 10% of the time at Nord? Ans. -40°F or lower. At Thule? At Eismitte?
(4) What percent of the time at Upernavik may the January daily minima be expected to range between -25°F and -10°F? Ans. 75% (85 - 10)

Upper line in column heading refers to percentage of days with indicated daily minimum temperatures or higher
Lower line " " " " " " " " " " " " lower

Churchill in January he must have protection for a daily minimum of -47°F or lower (30-year record).

Instead of a map showing -20°F, one may be constructed emphasizing the January daily minima in northern North America that may be expected 10% of the time. For example, suppose that an added garment is needed at 18°F, 0°F, and at -36°F, respectively, and that this garment should be issued as soon as the expected temperature is within 5F° of the critical temperature 10% of the time. Table IX furnished the necessary data for the construction of such a map (see Fig. 10). If Army personnel are to be stationed in central Alaska in January, the map shows where the critical -36°F may be expected.

8. Acknowledgment

Sincere appreciation is extended to Mr. Owen Parmele, formerly an associate in E.P.R.D., for access to his excellent frequency tabulations of daily minimum temperatures for Alaskan and Canadian weather stations. These data were essential to the construction of the adjusted probability scaler developed in this study.

9. References

1. Climatic Summary, Bulletin W, U.S. Weather Bureau, Government Printing Office, Washington, D.C.

2. de Percin, Fernand and Sigmund J. Falkowski, Frequencies of Selected Low Temperatures in Alaska, Technical Report EP-6, QM R&D Command, Natick, Mass., 1955

3. Hogue, Donald W., Temperatures of Northern North America, Research Study Report RER-9, QM R&E Command, Natick, Mass., 1955.

4. Lackey, Earl E., A Graphic Method for Assessing Hourly Temperature Probabilities, Technical Report EP-46, QM R&D Command, Natick, Mass., 1957.

5. Parmele, Owen S., Frequency Distribution of Minimum Daily Temperatures for Canada and Alaska, MS Tabulation, E.P.D., QM R&D Command, Natick, Mass.

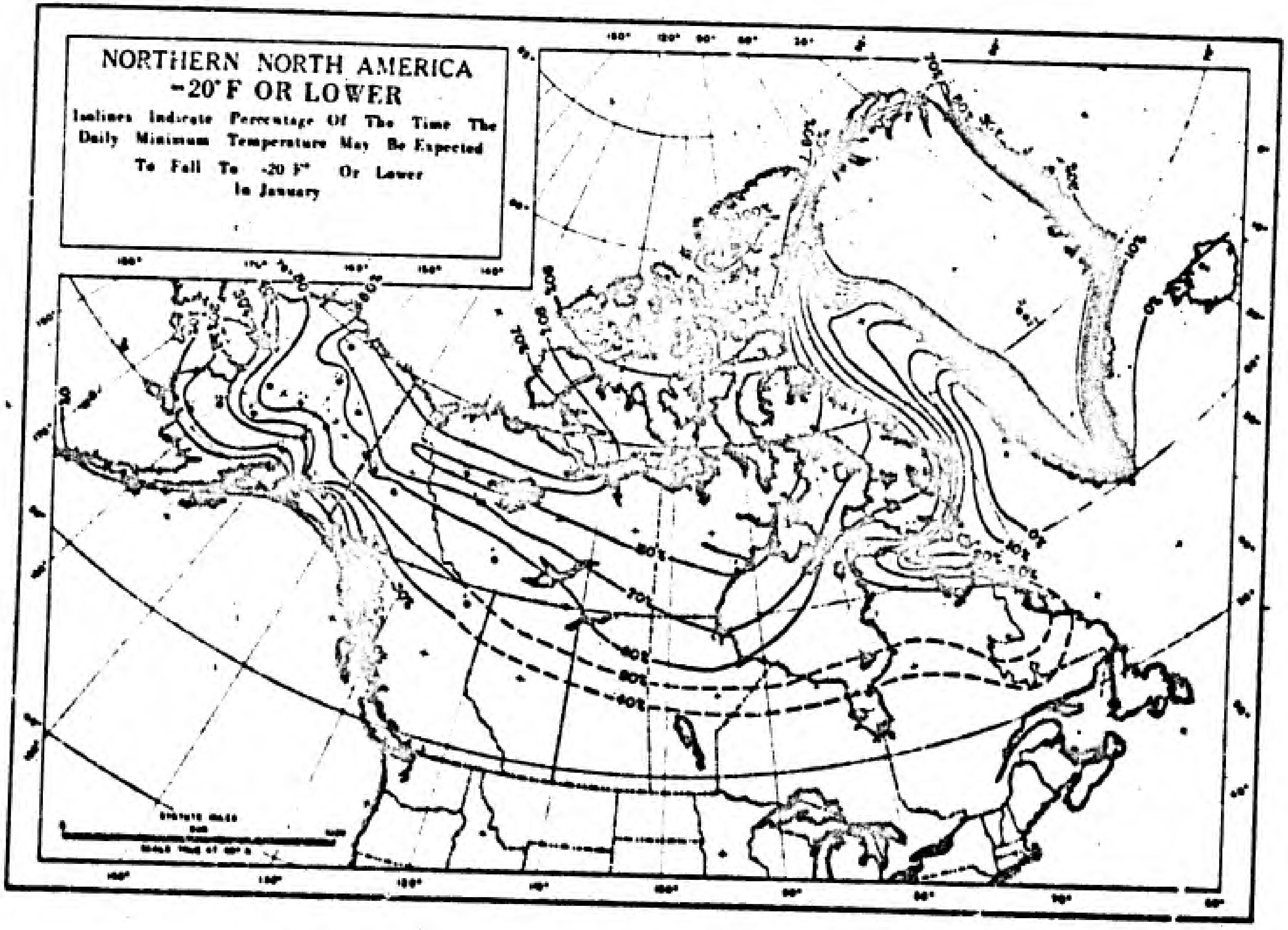

Figure 9. January Daily Minimum Temperatures, -20°F or Lower

Figure 10. January Daily Minimum Temperature Probabilities 10 Percent of the Time

Appendix

Daily Minimum Probability-Scale for January, Based on Mean Monthly Temperatures in Place of Mean Daily Minima

If mean monthly temperatures are substituted for the mean daily minima in Table I, then Figure 11 may be constructed by the same methods used for Figure 4.

Table X shows how well this scale assesses the daily minimum probabilities. The differences between daily minimum probabilities and the actual minima are somewhat larger than they are in Table 4. This scale could be used to advantage when mean monthly temperatures are available, but not the mean daily minima.

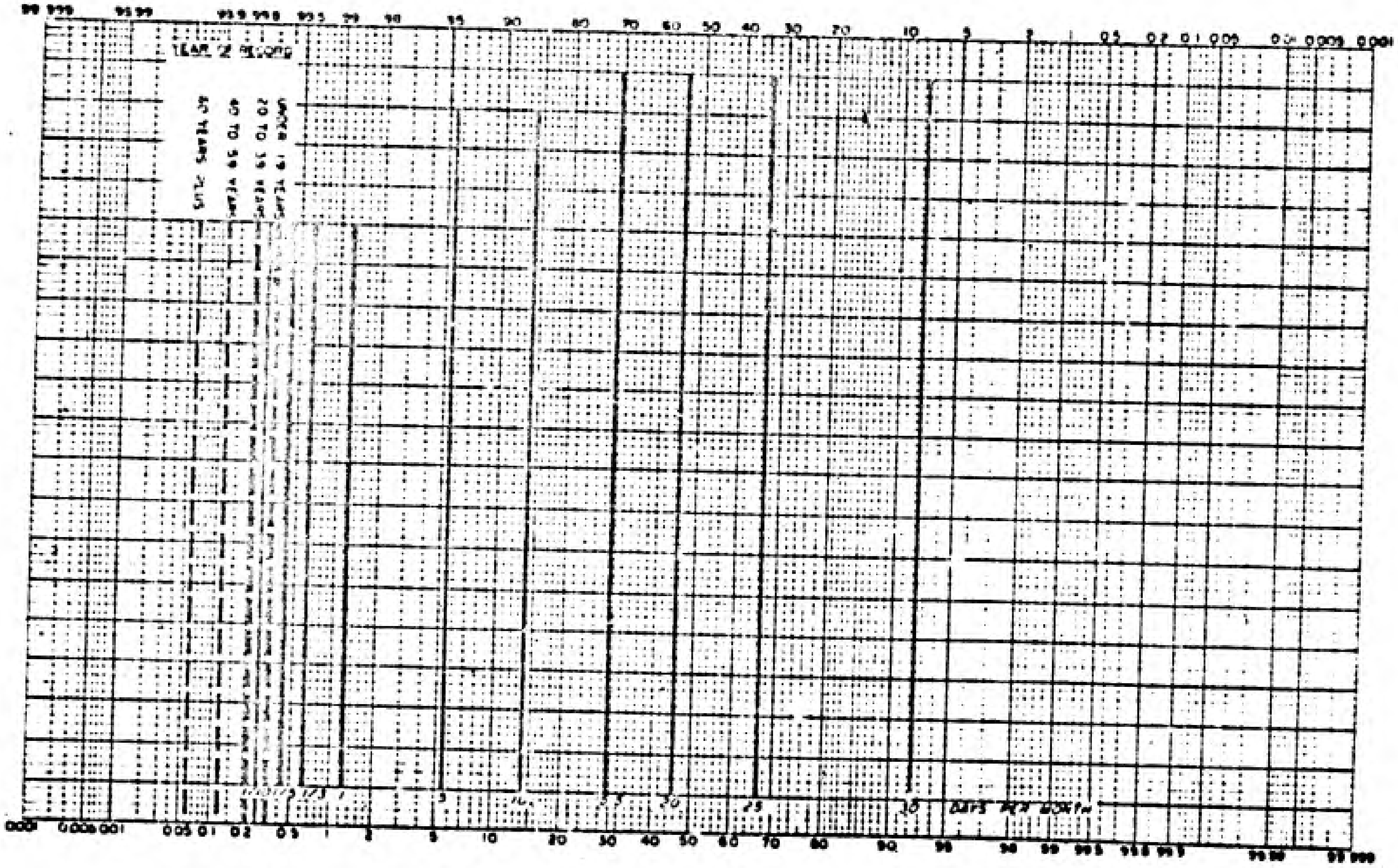

Figure 11. January Daily Minimum Temperature Probability Scale Based on the Monthly Mean, the Absolute Minimum, and Length of Record

Table 7: Comparison of departure of actual January daily minima at 10 component stations from minima estimated from two adjusted probability scales (Figures 4 and 11) for selected number of days per month (F°)

COMPONENT STATIONS		Differences in F° between Daily Minimum Probabilities and Actual Frequency Values, by Percentage and Days per Month 30 (96.8)	25 (80.6)	20 (64.5)	15.5 (50.5)	10 (32.2)	5 (16.1)	1 (3.2)	1/3 (1.1)	1/5 (0.65)	1/10 (0.32)
CANADA											
Aklavik	(a)	+1	0	0	0	-1	-2	-1	-1	-1	0
	(b)	-1	-2	-2	-2	-3	-5	-3	-2	-1	-1
Churchill	(a)	+4	+1	-1	-2	-1	0	-1	-1	-1	0
	(b)	+3	-1	-2	-3	-3	-1	-3	-3	-2	0
Coppermine	(a)	-0	-1	-1	-2	0	+1	+1	+1	0	+1
	(b)	-1	-0	-0	-1	-1	0	+1	0	0	-1
Dawson	(a)	-4	+2	+2	+2	0	+1	0	+1	-1	0
	(b)	+1	-2	+1	+2	-2	-5	+4	+5	+6	-1
Fort Smith	(a)	-3	-2	-1	+1	0	0	-1	0	0	+1
	(b)	-1	-1	-3	-4	-2	-1	+2	0	-1	-2
Pangnirtung	(a)	+2	+1	-3	-1	-2	-2	-2	0	0	0
	(b)	-1	-2	-2	-3	-4	-3	-1	-2	+2	+4
Pond Inlet	(a)	+5	+2	0	0	-3	-2	-2	-1	-1	-1
	(b)	-1	-4	-4	-4	-7	-6	-5	-4	-3	-2
ALASKA											
Barrow	(a)	+4	-2	0	0	+2	4	6	+7	+7	+4
	(b)	+1	-2	+4	+3	+3	+4	+6	+4	+7	0
Kotzebue	(a)	-2	0	+1	-1	+1	+2	-1	-2	-2	0
	(b)	+5	+5	+5	+2	+2	+1	+2	-5	-4	-1
Tanana	(a)	-11	-3	+1	+4	+5	+4	+1	+2	+1	+3
	(b)	+6	0	+4	+6	+4	+2	-2	-2	-2	+1

*Plus (+) indicates that the probability scale (Figure 4) gave temperatures which were higher than the recorded, and minus (-) indicates that the scale gave readings which were lower.

(a): Differences using Figure 4, featuring mean daily minimum temperatures
(b): " " " 11, " mean daily or mean monthly temperatures

UNCLASSIFIED

AD 162746

Armed Services Technical Information Agency

ARLINGTON HALL STATION
ARLINGTON 12 VIRGINIA

FOR
MICRO-CARD
CONTROL ONLY

1 OF 1

UNCLASSIFIED